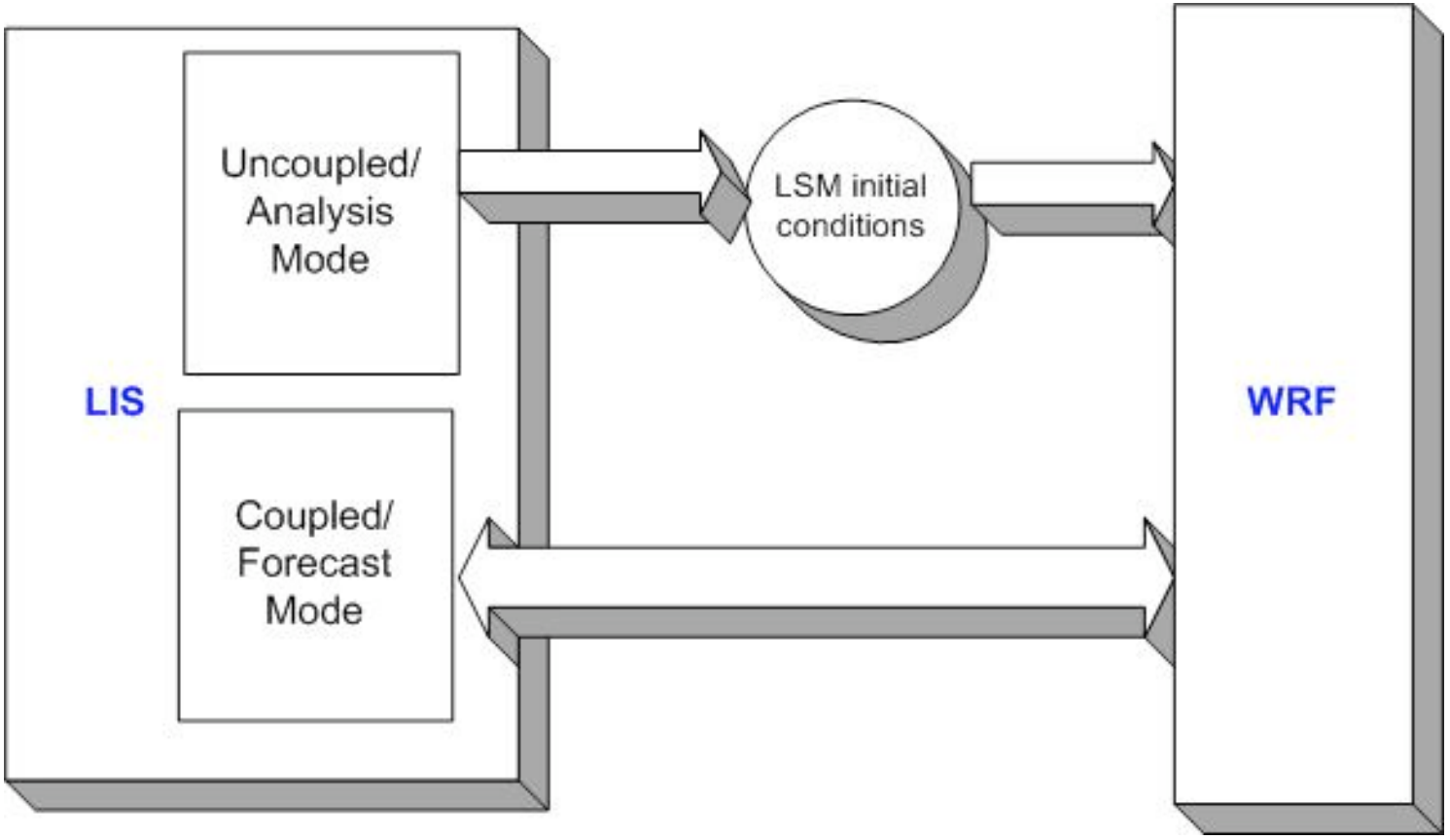
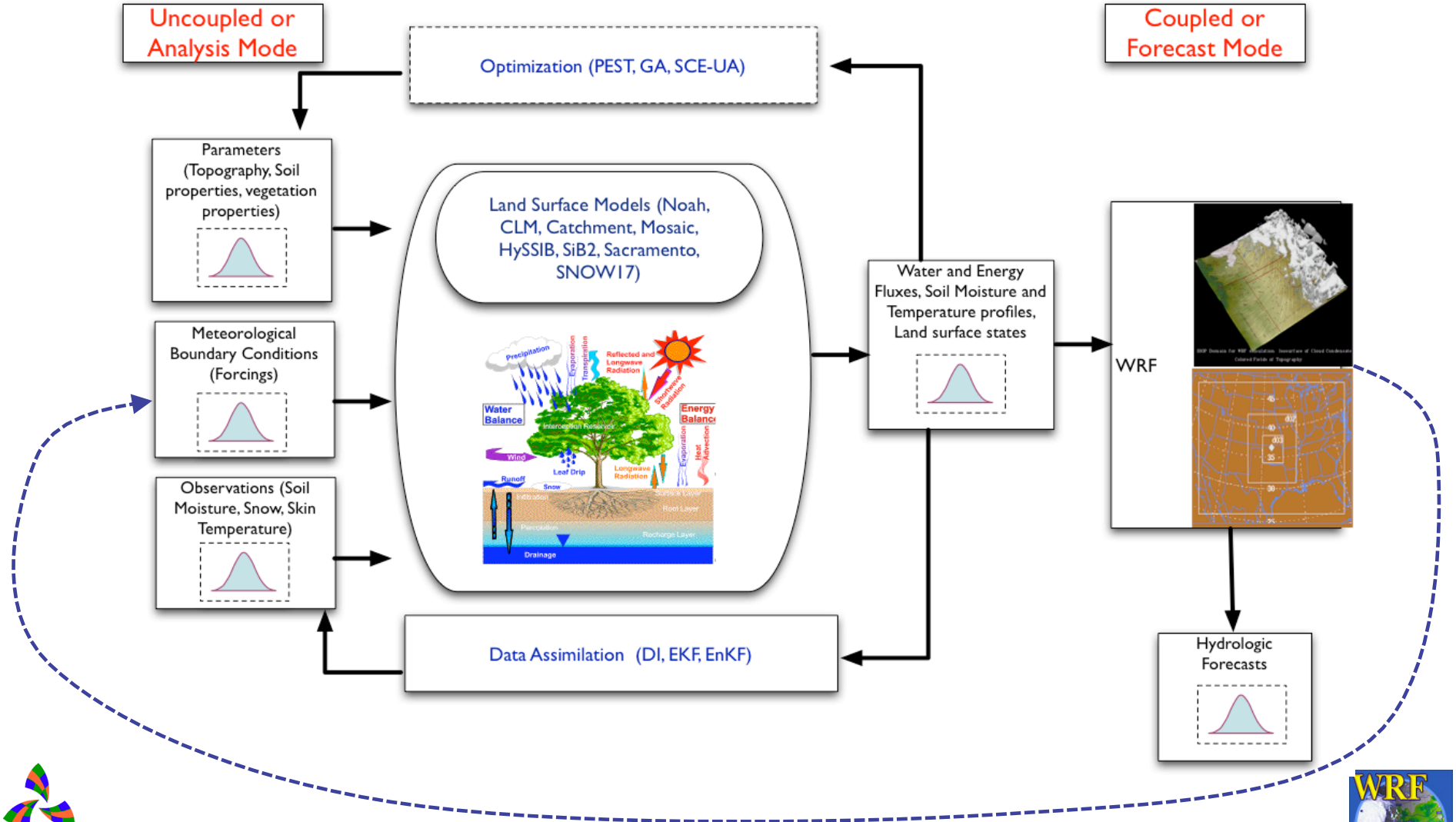
Importance of LIS-WRF Coupling

- No routine high-resolution soil observation network at continental/global scales available for initialization of the coupled modeling systems
- Solution: Drive land surface models (LSMs) with accurately specified atmospheric boundary conditions in a Land Data Assimilation System (LDAS) framework to generate initial land surface conditions
- Allows “plug and play” evaluation of the sensitivity of convective initiation, and sensible weather forecasts to different land surface analyses
- Spin-up of land surface to high resolution parameters (no terrain/parameter mismatch)
- Use of data assimilation techniques
- Utilize and assimilate high resolution satellite data
- Multiple land surface models
- Offline evaluation and development of land surface schemes and parameters

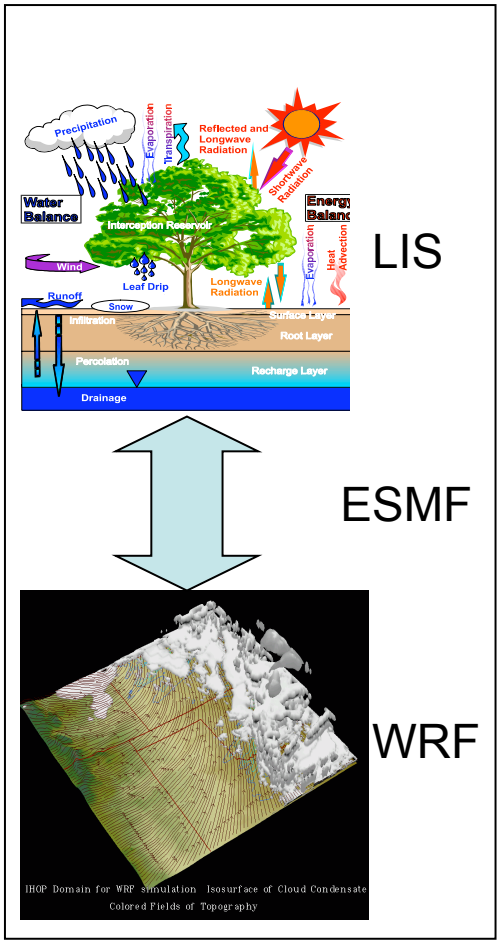
LIS-WRF Coupled System

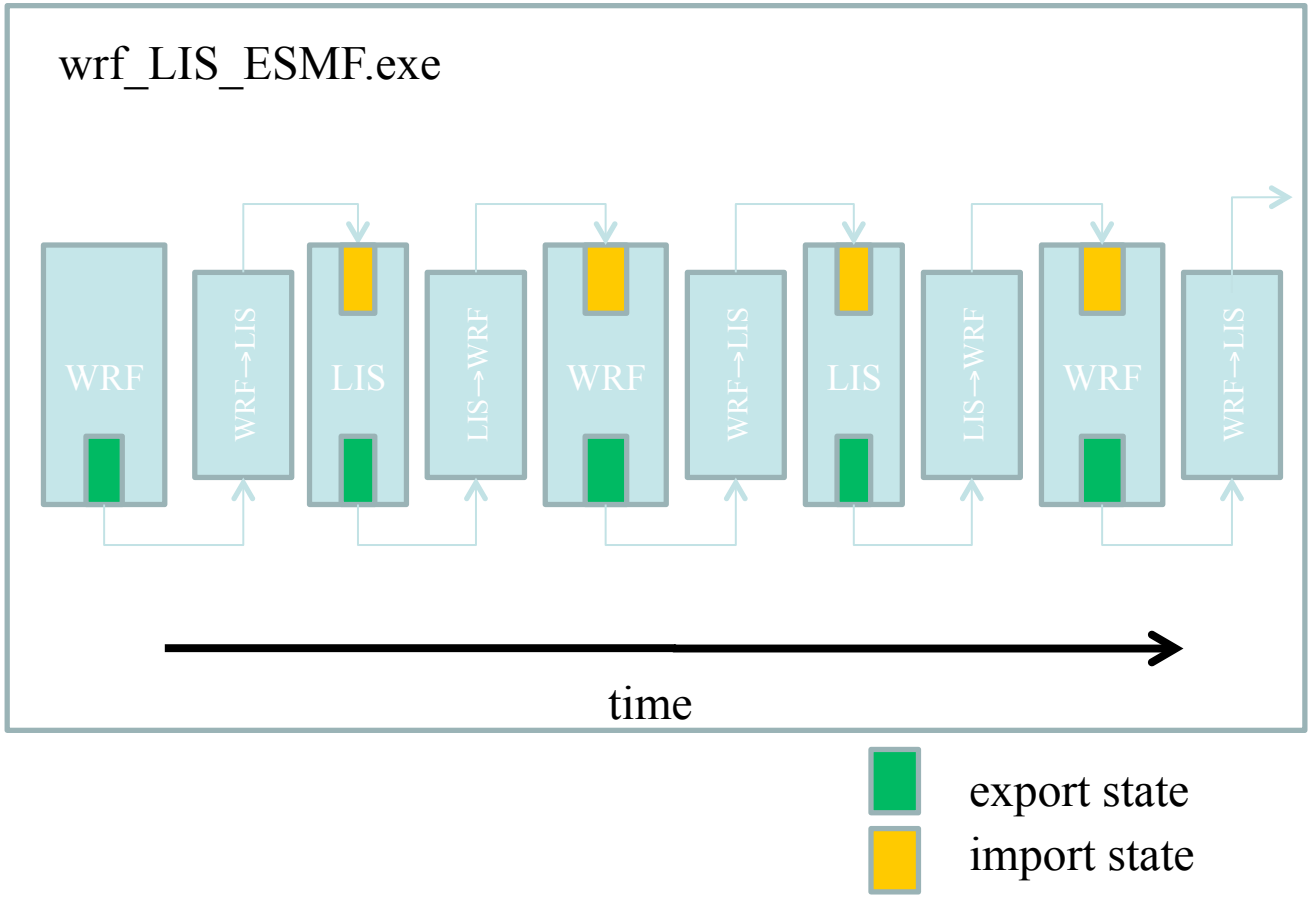


LIS-WRF Coupled System

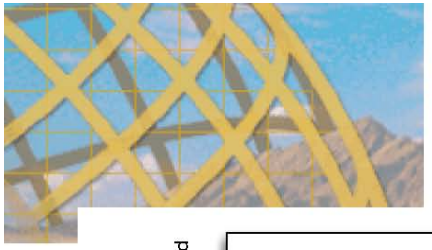


LIS-WRF Coupled System

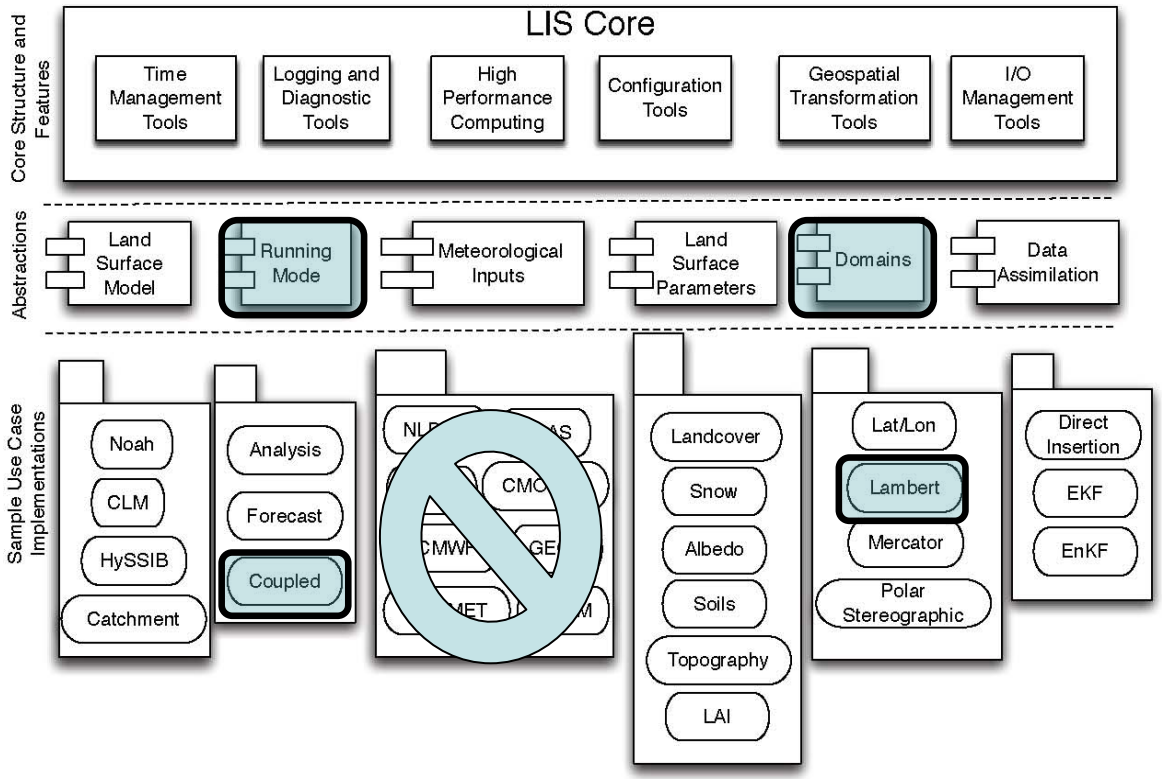




LIS-WRF Coupled System



LIS Software Structure



LIS-WRF Coupled System

- LIS-WRF Experimental Design
  - Determine region and time period of interest
  - Assess available init/bdy conditions data for WRF
  - Assess available forcing/parameter data for LIS
  - Run WPS (geogrid, ungrib, metgrid) and real.exe to create wrfinput/wrfbdy conditions and specify the exact domain (and nested domain)
  - Run LIS offline on this domain for a 2-4 year period prior to the initial time of the experiment to ‘spinup’ or equilibrate the land surface states
  - Use the LIS restart (after spinup) with wrfinput/ wrfbdy files to initialize and run LIS-WRF

LIS-WRF Coupled System

- Go to Word Doc….

LIS-WRF Coupled System

- LIS(v5)-WRF(v2.2)

  Passing of variables occurs in:

  WRF-side: /WRF/phys/module_surface_driver.F

  LIS-side: /lis/runmodes/wrf_cpl_mode/*.F

- LIS(v6)-WRF(v3)

  Passing of variables is handled more formally by WRF and fully ESMF-compliant:

  Registry entries added

  main/module_wrflis_coupler.F

Coupled LIS-WRF System

Weather Research and Forecasting (WRF) Model

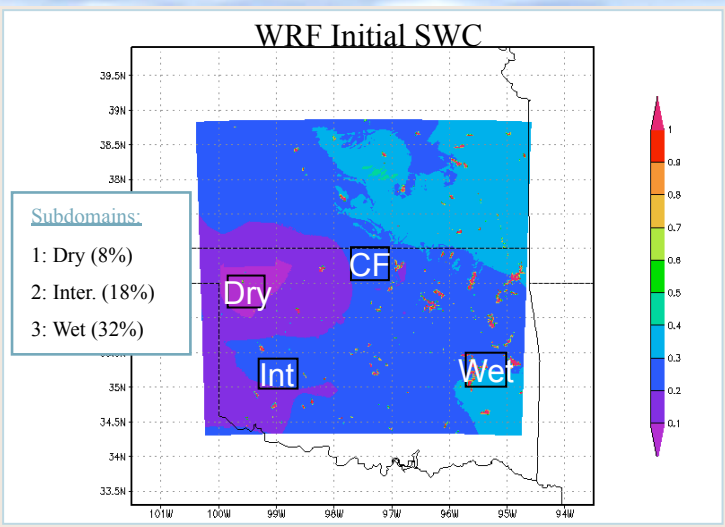
- 1-km horizontal resolution
- NARR forcing
- 43 vertical levels (~42m sfc)
- 3 PBL + 3 LSM schemes:
  → 9 combinations of L-A coupling
- Case studies:
  → IHOP02, CASES99, Cabauw

WRF – THE WEATHER RESEARCH & FORECASTING MODEL

NASA's Land Information System (LIS)

- Suite of LSMs with flexible resolution, forcing, params
- Provides spinup capability for improved initialization
- NASA's 'Software of the Year'

LIS



Initial soil moisture for the WRF 1km-domain and locations of the dry, intermediate, and wet analysis regions and ARM-SGP Central Facility.

Land Surface Models

Noah (v2.7.1)
- 4 soil layers (10 cm upper)
- Derived from the OSU LSM
- Soil moisture and temp; veg, snow

Community Land Model (v2)
- 10 soil layers (2 cm upper)
- Extensive canopy and veg,
- Soil moisture, temp; veg, snow

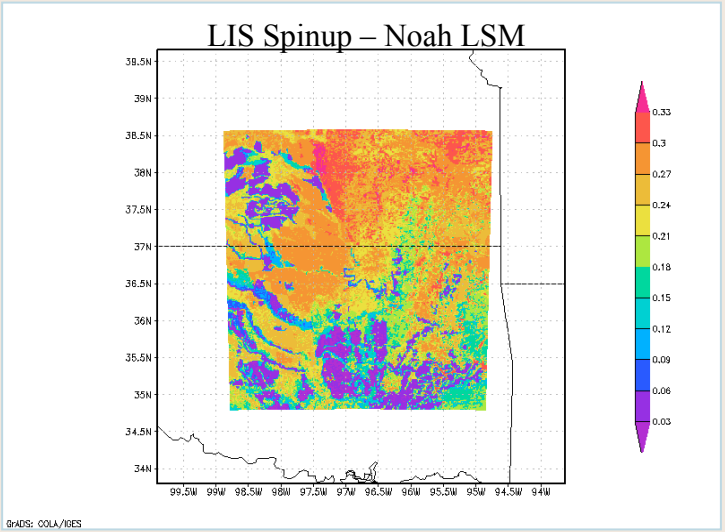
TESSEL
- ECMWF operational lsm
- HTESSEL – latest version
- Tiled soil, canopy, snow sfc's

PBL Schemes

YSU (Yonsei University)
- Counter-gradient fluxes; Non-local K theory
- Explicit entrainment at PBL top
- PBL Height from critical Ri number

MYJ (Mellor-Yamada-Janjic)
- Nonsingular M-Y level 2.5 closure
- Length scale limited by TKE, buoyancy, shear
- PBL Height diagnosed based on TKE production

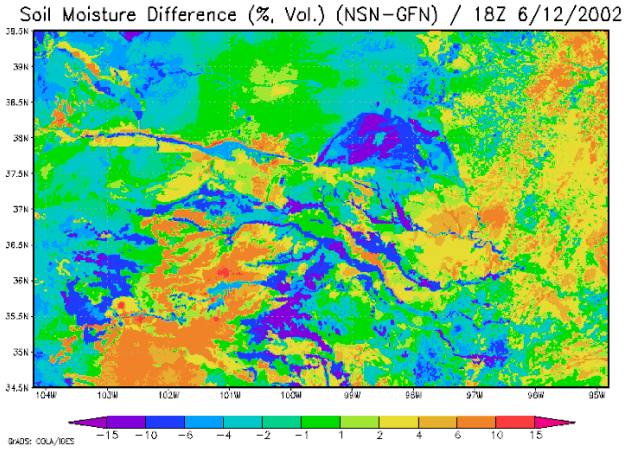
MRF
- Based on YSU scheme
- Implicit (local) vertical diffusion

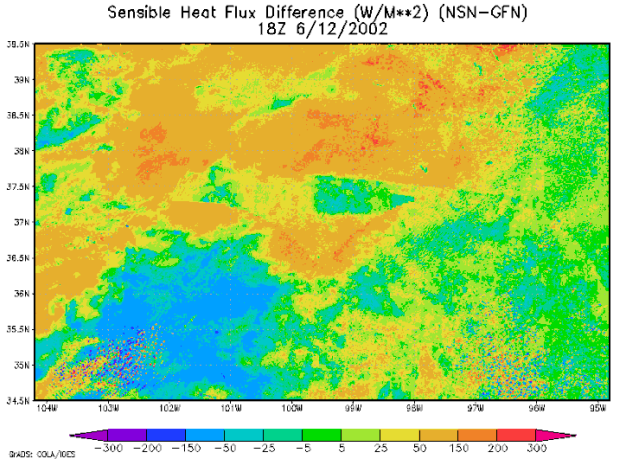


NASA ENERGY AND WATER CYCLE STUDY

Results – Impacts of Land Surface

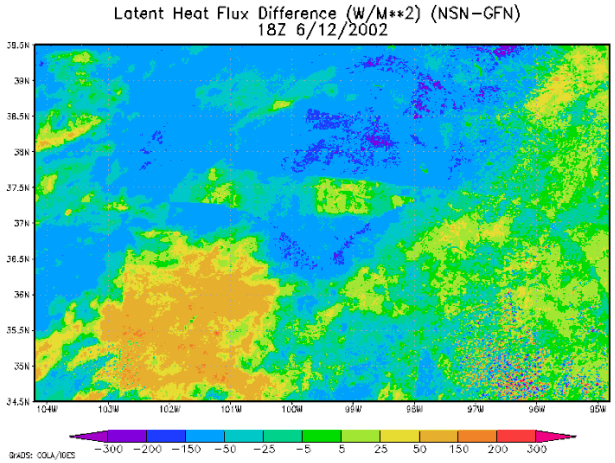
Soil Moisture Difference

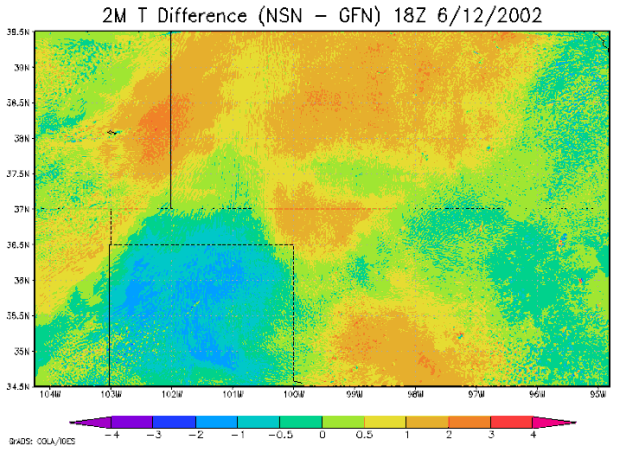




Sensible Heat Flux Difference

Latent Heat Flux Difference





2M Temperature Difference